EXPERIMENT 6: PROJECTILE MOTION

PURPOSE:
To Predict where a horizontally projected object will land and to get a better understanding of projectile motion.

EQUIPMENT:
1 inclined plane (for the ball to gain speed before leaving the table. For example sargent welch (WLS1826-71) , plumb-bob, stop watch, large paper, carbon paper, measuring tape, TI calculator, white masking tape

DATE______________

AUTHOR ____

PARTNER _______________________________________

PARTNER _______________________________________

BACKGROUND

There are basically three kinds of motion: (1) the horizontal, straight-line motion of objects moving on the surface of the earth ; (2) the vertical motion of dropped objects that accelerate toward the surface of the earth; and (3) the motion of an object that is projected in the air. The third type of motion, projectile motion, could be directly upward as a vertical projectile, straight out as a horizontal projection, or at some angle between the vertical and the horizontal. Basic understanding of such compound motion is to understand that:

- gravity always acts on objects, no matter where they are

- the acceleration due to gravity (g) is independent of any motion that an object may have : The horizontal motion is independent from the vertical motion

As an example of projectile motion, consider the figure below. After rolling down the incline (AB), the ball moves across a frictionless, horizontal track (BC). While the ball is on the track BC, and ignoring air resistance, **<u>the speed of the ball is constant</u>** because there are no net force acting on the ball (gravity is balanced by recoil from the table and no friction along horizontal)

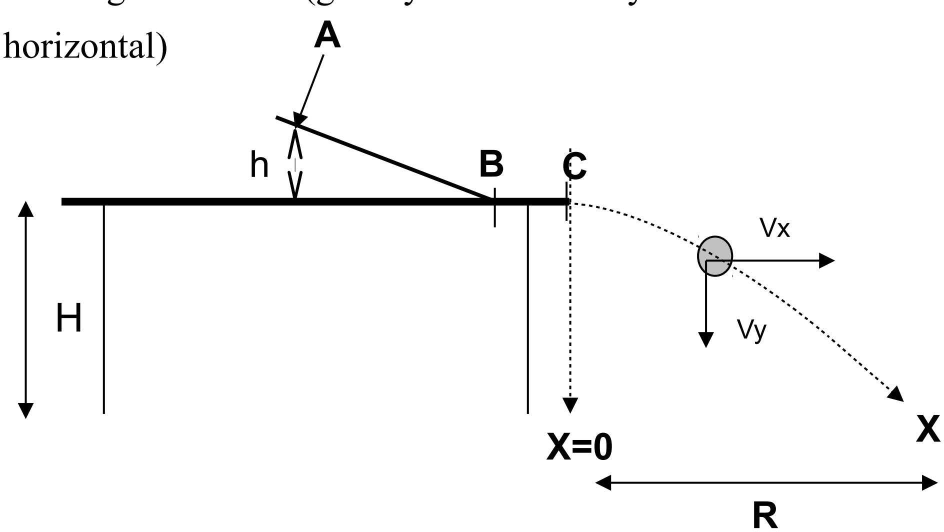


Figure 1

After the ball leaves the track BC, it becomes a projectile at C. The motion of such projectile is easier to understand if you split the complete motion into vertical and horizontal parts.

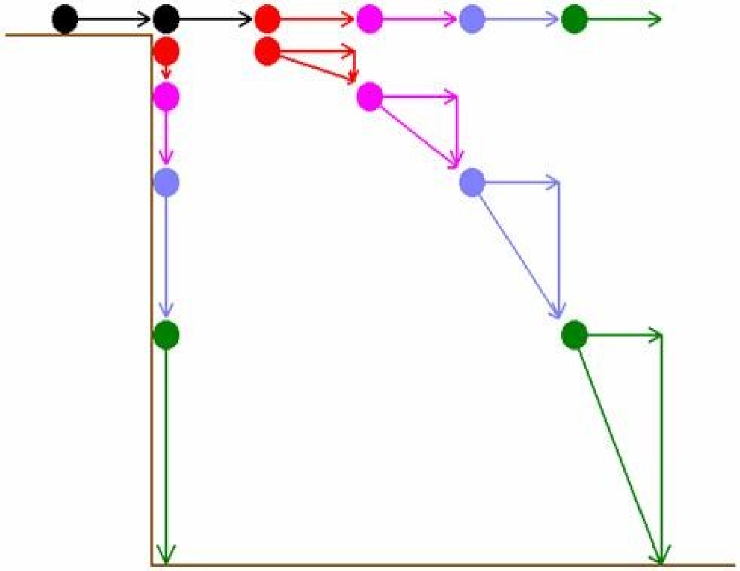


Figure 2 : the parabola is the actual trajectory of the ball after it left C. It combines a horizontal motion and a vertical motion shown in the figure. The velocity of the ball has 2 components.
The x-component Vx (constant with time) and the y-component Vy (increases with time).

After the ball leaves the track, there is an unbalanced force (weight = mg) that accelerates the ball downward. The ball thus has an increasing downward velocity (Vy) .
There is no force in the horizontal direction so the horizontal velocity remains the same as shown by the figure 2. The combination of the vertical motion (Vy) and the horizontal motion (Vx) causing the ball to follow curved path until it hits the floor.

1- Let's call H the height of the table. The ball will fall this distance.

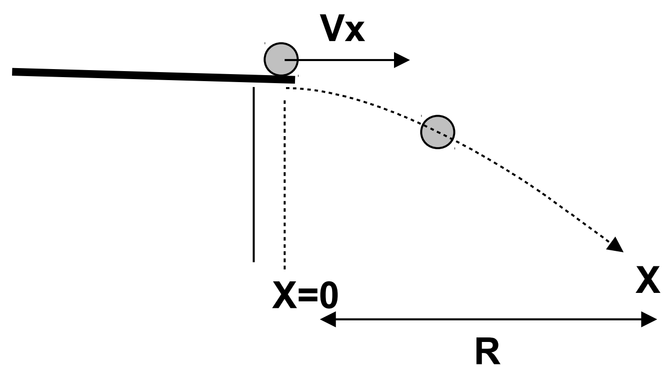
g = 980cm/s/s

$H = \frac{1}{2} g t^2$ (1) From free-fall

2- Let's call **R** the range of the projectile. Or horizontal displacement.
R depends solely on **Vx** when it leaves the horizontal track.

$V_x = R/t$ and $t = R/V_x$ (2)

If you substitute **(1)** in **(2)** you get:



$$\mathbf{H = ½\, g\, (R/Vx)^2} \quad \text{or}$$

$$\mathbf{H = ½\, 980\, (R/Vx)^2}$$

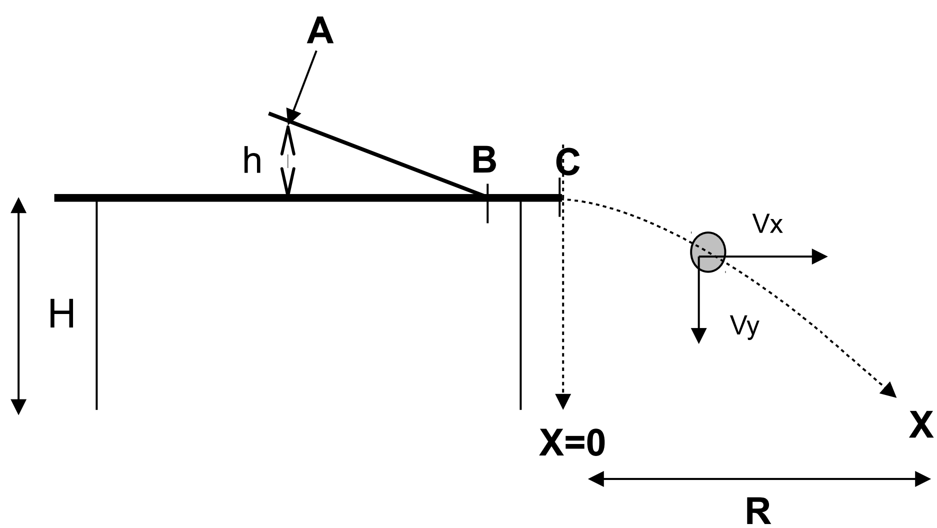
$$\text{or } \mathbf{2H = (980\ R^2) / Vx^2}$$

$$\text{or } \mathbf{R^2 = (2H\ Vx^2) / 980 \quad (3)}$$

In this lab, You will predict **R** using the equations of motion and check your prediction.

PROCEDURE:

STEP1: Place the inclined plane about 20cm from the edge. Make a mark (with tape or chalk) on the top of the ramp. This is your point A (see **Figure 1** below). Find the **height h** between the table and the ramp placed at A. **h = ________ cm**



The ball will speed up between A and B then will move at a constant speed **Vx** between B and C before leaving C. It will keep the same horizontal speed **Vx** in the air while the vertical speed **Vy** increases in magnitude. (figure 2 above).

Step2: Let's find the speed **Vx** between B and C using conservation of energy

potential energy at the top of the ramp = kinetic energy at the bottom of the ramp/

mass x gravity x h = 0.83 x mass x (final speed)^2

0.83 x (Vx)^2 = 980 x h (you can cross out the mass of the ball from both side)

Solve for **Vx = ________ cm/s .** (Vx =√(980 h /0.83))

STEP3 : Measure the height of the table **H** = _____ **cm** with a measuring tape.

This is the vertical displacement of the ball.

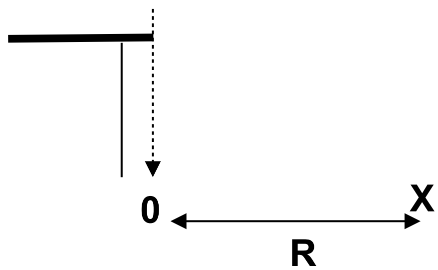
STEP 3: From the equation **(3) $R^2 = 2H\ Vx^2\ / 980$**

solve for **R** using the values of **H** and **Vx** (take square root $R = \sqrt{(2\ H\ Vx^2 / 980)}$)

R = ___________ cm

STEP4: Use the plumb-bob line to find the point directly below the end of the ramp. This should be called point 0.

Use a piece of tape to mark point 0.



Use the value **R** computed in step 3 to measure that distance from the point 0 going outwards. This is where the ball is estimated to land. Tape a **piece of paper** and center it at the point where the ball is estimated to land. Mark the location of the predicted **X** on the paper centered on R.

Trace a line that goes through the X at a distance R from the 0. Check with your instructor.

Step5.

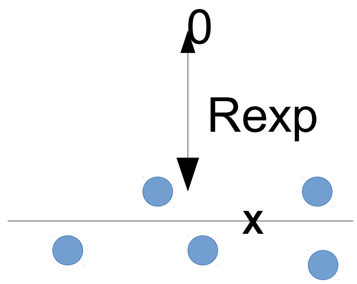
Cover the paper with a carbon paper and tape it down. **Make sure the ramp does not move**.

Make sure there is no gap between the ramp and the table. If there is a gap, the ball will tend to jump and to pick up momentum and it will go farther than predicted. You can hold the ramp down to close the gap.

Make sure the ramp is at the same position for each trial. Roll the ball down the ramp 10 times. Readjust the ramp each time. The ball should not jump. Reject the trial if the ball goes too much on the side. If your prediction is correct, the ball should land on both side of the line.

With a meter tape measure the distances (**Rexp**) between 0 and the dots. Record in the following table.

Rexp is the distance between point 0 and the dot left by the ball on the white paper. (next page)



Rexp values (cm):

Rexp average = ____________ cm

ANALYSIS

1) are the dots spreads about the line ?

2) Find the difference between Rexp and Rpredicted = ________ cm

Are the 2 values close?

3) Compute the discrepancy % between the average and the predicted value.

3) Increase the height of the ramp and release the ball. How is the distance from the dots to point 0 different?

CONCLUSION: